STUDIES ON THE MOST TRADED MEDICINAL PLANTS FROM THE DOLPA DISTRICT OF NEPAL

Mohan B. Gewali
Division of Visiting Professors
Institute of Natural Medicine
University of Toyama

Abstract

The traditional uses, major chemical constituents and prominent biological activities of the most traded medicinal plants from Dolpa district of Nepal are described in this article.

Cradled on the laps of the central Himalayan range, Nepal (147,181 Km^2) is sandwiched between two Asian giants, India on the South and China on the North. Nepal is divided into 14 zones and 75 districts. The Karnali zone, which has a border with Tibet region of China, is made up of five districts. Dolpa district (7,889 km^2) is one of them.

Dolpa district's topography starts from the subtropical region (1575 meter) and ends in the nival region (6883 meter) in the *trans*-Himalayan region. The district has a population of about 29545 with Hindu 60%, Buddhist 40% including 5.5% ancient Bonpo Religion. Major ethnic groups/castes belonging to both Hindu and Buddhist religions include Kshetri, Dangi, Rokaya, Shahi, Buda, Thakuri, Thakulla, Brahmins, Karki, Shrestha, Sherpa and other people of Tibetan origin. The languages spoken are *Nepali*, *Dolpo* and *Kaike*. *Dolpo* is a variant of the Tibetan language. *Kaike* is considered indigenous language of Tichurong valley. In the Dolpa district, the traditional Tibetan medical practices are common. The traditional Tibetan practitioners called the *Amchis* provide the health care service. The *Amchis* have profound knowledge about the medicinal herbs and the associated healing properties of the medicinal plants found in the Dolpa district.

As far as the ethnomedicinal resources of the Dolpa district is concerned, there seems to be three key studies. They are *Medicinal Plants of Dolpo: Amchi's Knowledge and Conservation* (1), *Ethnomedicine of Dolpa district, Nepal: the Plants, their Vernacular Names and Uses* (2) and *Ethnomedicine in Himalaya: a case study from Dolpa, Humla, Jumla and Mustang districts of Nepal* (3). In *Medicinal Plants of Dolpo: Amchi's Knowledge and Conservation*, descriptions as regards to the *Amchis*'s

traditional medical and ethnoecological acumen, relationship between conservation, health care and the trade of medicinal plants as well as the traditional uses of 100 medicinal plants in Shey Phoksundo National Park and its buffer zone are presented. The second study, *Ethnomedicine of Dolpa district, Nepal: the Plants, their Vernacular Names and Uses*, documents 58 medicinal plant species used by the local people of dunai, juphal, suu, sahartara and majphal villages of the Dolpa district. Furthermore, from dunai, juphal, raha, tripurakot and phoksundo villages of Dolpa district, 107 plants of the ethnomedicinal importance are reported in *Ethnomedicine in Himalaya: a case study from Dolpa, Humla, Jumla and Mustang districts of Nepal*. The *Amchis* of the Dolpa district are reported to use at least 375 plants in their traditional treatment to cure variety of the diseases (4). Based on the records available in the District Forest Office as well as field surveys during the period of 1992/1993 and 1997/1998, 20 plants were found to be the most traded from the Dolpa district (5). The names of these 20 plants are given in the following table.

	Trade name	**Scientific name**
1	Atis	*Delphinium himalayai* Munz
2	Bhutkesh	*Selinum wallichianum* (DC.) Raizada & Saxena
3	Bojho	*Acorus calamu*s L.
4	Chau	*Morchella esculenta* (L.) Pers. ex Fr.
5	Chirayita	*Swertia chirayita* (Roxb. ex Fleming) Karsten
6	Dhupi	
7	Dhupjadi	*Jurinea dolomiaea* Boiss.
8	Jatamansi	*Nardostachys grandiflora* DC.
9	Kakarsinghi	*Pistacia khinjuk* Stocks
10	Kurilo	*Asparagus* sp.
11	Kutki	*Neopicrorhiza scrophulariiflora* (Pennell) D.Y. Hong
12	Nirbisi	
13	Okhar	*Juglans regia* L.
14	Padamchal	*Rheum australe* D. Don
15	Kaladana	
16	Salla simta	*Pinus wallichiana* A. B. Jacks.
17	Satuwa	*Paris polyphylla* Sm.
18	Satawari	*Asparagus racemosus* Willd.
19	Sugandhbal	*Valeriana jatamansii* Jones
20	Titepati	*Artemisia* sp.

In this article, out of these 20 most traded plants, 15 plants were selected. The chemical constituents and biological activities present in these 15 plants were searched. The traditional uses of the plants are taken from recently published two ethnomedicinal studies of the Dolpa district (2) (3). If the traditional uses of certain plants are not obtained in these two studies, information as regards to the traditional use is sourced from *National Register of Medicinal Plants* (6). Most of the distribution and location of the plants are based on the information obtained from *Annoted Checklist of the Flowering Plants of Nepal* (7). The following is the description of the traditional uses, principal chemical constituents and major biological properties of the 15 most traded medicinal plants from the Dolpa district.

Delphinium himalayai

Delphinium himalayai Munz. (Amchi term: *Atik*; Nepali language and trade name: *Atis*) belongs to the family Ranunculaceae. It is distributed in Nepal at the elevation range of 3000 to 4500 meter.

Traditional use

Its root has been used as an astringent. The root juice is useful in case of snakebite, cough, fever, liver problems and headache.

Chemical constituents and biological properties

Chemical and biological studies are lacking in this plant.

Selinum wallichianum

Selinum wallichianum (DC.) Raizada & Saxena (Synonym: *Selinum tenuifolium* Wall. ex C. B. Clarke) (Amchi term: *Tanak*; Nepali language and trade name: *Bhutkesh*) belongs to the family Umbelliferae. It is distributed in the Himalayan region (Kashmir to Bhutan), Tibet and China at the elevation range of 2600 to 4200 meter.

Traditional use

Root decoction is useful for diarrhea, cuts & wounds, fever, stomachache and vomiting. Root extract finds application in case of cold and cough.

Chemical constituents

Furocoumarins such as bergapten, heraclenol, heraclenin, angelicin and xanthotoxol have been isolated from the roots of *S. tenuifolium* (8). Two dihydropyranocoumarins, isopteryxin and anomalin, were also obtained from the ether extract of the roots of *S. tenuifolium*. Alcohol extract yielded sucrose and mannitol (9). Air-dried umbels of *S.*

tenuifolium was found to contain 0.56% isoimperatorin, 0.07% osthole, 0.036% imperatorin, and 0.4% oxypeucedanin where as its roots possessed 1.2% oxypeucedanin, 0.07% isoimperatorin, 0.02% osthole, and 0.007% imperatorin (10). The root essential oil was shown to contain limonene, elemol, terpineol, geraniol and eudesmol (11). *S. tenuifolium* leaves oil contained twenty-two compounds of which 3,5-nonadiyne (65.4%) and β-eudesmol (7.2%) were the major constituents. Its roots oil had sixteen constituents with 3,5-nonadiyne (89.7%) as the major component (12), (13).

Biological properties

Fatty acids and their esters isolated from *S. tenuifolium* was patented for their role as ganglioside metabolism accelerators (14).

Acorus calamus

Acorus calamus L. (Amchi term: *Tsu dak*; Nepali language and trade name: *Bojho*) belongs to the family Araceae. It is distributed in Nepal, Bhutan, China, India, Sri Lanka, northern Asia, Europe and Central and Northern America at the altitude range of 100 to 2300 meter

Traditional use

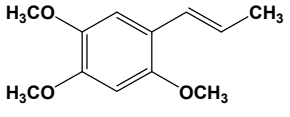
Dried rhizome has been used to treat headache, cold & cough, throat pain and toothache. It is also considered appetite stimulant. Rhizome extract is used to treat measles. It is also said to possess pesticidal properties.

Chemical constituents

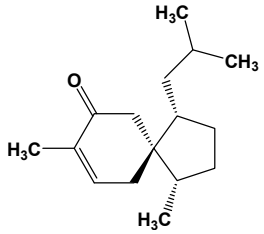
Compounds such as β-asarone (20.5-75.6%) and *cis*-methylisoeugenol (2.4-48.9%) dominated the essential oils of the root, rhizome and leaves of *A. calamus* var *angustatus* collected from different parts of Japan. Other minor constituents in these essential oils were methyleugenol, eugenol, *trans*-methylisoeugenol, elemicine, sekishone, *cis*- and *trans*-isoelemicine, α-pinene, camphene, β-pinene, limonene, 1,8-cineole, *p*-cymene, linalool, terpinen-4-ol, α-terpineol, α-ylangene, β-elemene, β-gurjunene, δ-cadinene, calamenene, calcacolene, epishyobunone, isoshyobunone and shyobunone (15). Mangolian *A. calamus* rhizome essential oil was found to contain 30 components with shyobunone (17.3%) and acorenone (14.4%) as principal constituents (16). The Indian rhizome essential oil had β-asarone (92.68%) as the main constituent (17). The rhizome essential oil of *A. calamus* obtained from the lower region of the Himalayas had 29 components among which β-asarone (83.2%) and α-asarone (9.7%) predominated. The essential oil of the leaves had 30 constituents with β-asarone (85.6%) and linalool (4.7%) as major components (18). The essential oil of *A. calamus*

roots obtained from Konya (Beysehir), Turkey contained 43 components with preisocalamendiol (17.3%), isoshyobunone (13.0%), 1,4-(*trans*)-1,7(*trans*) -acorenone (10.5%), camphor (5.9%), 2,6-diepishyobunone (2.6%) and *β*-gurjunene (2.5%) as the major constituents (19). Furthermore, the rhizome and roots of *A. calamus* were shown to contain different sets of compounds in their essential oils The major components of the rhizome essential oil were *β*-asarone (47.43%), calamenene (9.75%), isocalamendiol (5.41%), preisocalamendiol (3.53%) where as the root essential oil possessed calamene (20.00%), aristolene (15.71%), acoradiene (14.19%) and *cis*-isoelemicin (9.51%) as major components (20). In the rhizome collected in Quebec, Canada, the essential oil contained preisocalamenediol, acorenone, shyobunone, and cryptoacorone (21). Lithuanian *Acorus* rhizome essential oil was shown to possess oxygenated sesquiterpenes such as shyobunone isomers (14.8-27.8%) and acorenones (9.6-21.4%). (*Z*)-asarone was detected in the rhizomes, but was present in noticeably minor amount (4.3-9.6%) as compared to the leaf oil The leaves had (*Z*)-asarone (15.7-25.5%) and (*Z*)-methylisoeugenol (2.0-4.9%) (22). Aside from *Acorus* leaves main components, (*Z*)-asarone (15.7-25.5%) and (*Z*)-methylisoeugenol (2.0-4.9%), other components detected in the leaves were (*E*)-caryophyllene, *α*-humulene, germacrene, linalool, camphor and isoborneol (23).

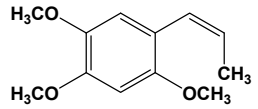
Among some other isolated sesquiterpenoids include acoragermacrone (24) acolamone, isoacolamone (25) calamenone, calamendiol, (26) and acorafuran (27). A cyclobutane derivative probably formed by 2 + 2 cycloaddition of asarone named acoradin together with 2,4,5-trimethoxybenzaldehyde, 2,5-dimethoxybenzoquinone and *β*-sitosterol were isolated from the rhizomes of *A. calamus* (28). Flavonoids such as galangin (28) and luteolin 6,8-C-diglucosides (29) have also been reported from *A. calamus*. The structures of representative isolated compounds are presented below.



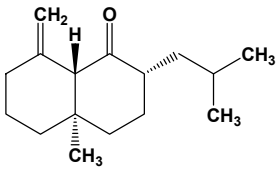
trans-asarone (α-asarone)



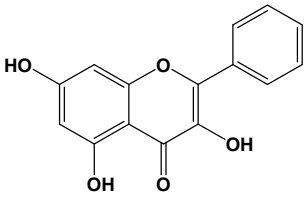
acolamone



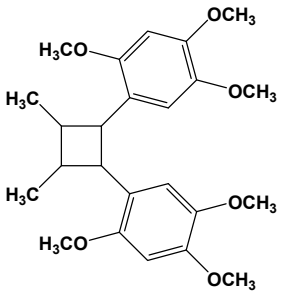
***cis*-asarone (*β*-asarone)**



acarenone



galangin



acoradin

Biological properties

A. calamus rhizome and leaf essential oils were tested against three bacteria, four yeasts and ten fungal species. Leaf oil was found to be more antimicrobial than the rhizome oil (22). Anticonvulsant, antiveratrinic, and antiarrhythmic properties of *A. calamus* essential oil have been reported (30). *A. calamu*s extract showed depressant action on normotensive dogs, inhibited the rate of contraction of frog and dog hearts, relaxed the tone of isolated intestine, uterus, and bronchi and antagonized acetylcholine and histamine-induced spasms (31). A sedative as well as hypnotic potentiating principle has been separated from the volatile oil distillate of *A. calamus* (32). *A. calamus* essential oil's spasmolytic activity in isolated organs of certain experimental animals has been studied. Its spasmolytic activity was found to be roughly 10% of that of papaverine (33). *A. calamus* aqueous and alcoholic extracts exhibited hypothermic and hypotensive activities (34). The ethanol extract of *A. calamus* had significant hypolipidemic activity (35). The ethanol extract of *A. calamus* inhibited growth of several cell lines of mouse and human origin. It was also found to inhibit production of nitric oxide (NO), interleukin-2 (IL-2) and tumor necrosis factor-alpha (TNF-alpha). These findings were indicative of antiproliferative and immunosuppressive potentials of the ethanol extract of *A. calamus* rhizome *in vitro* (36). The effects of water-soluble dried powder of alcoholic extract of the roots and rhizomes of *A. calamus* on strychnine induced convulsion activity in frogs, spontaneous motor activity and amphetamine induced hyperactivity in mice, pentobarbitone induced sleeping-time in rats and local anesthetic activity in guinea pigs and rabbits were studied. The extract neither offered protection to strychnine induced convulsions nor to acetylcholine induced contractions of rectum muscle. However, it inhibited caffeine citrate induced contractions in frogs. The extract further was found to antagonize spontaneous motor activity as well as amphetamine induced hyperactivity in mice. The extract, however, lacked local anesthetic activity (37). *cis*-Asarone was found to be antifungal agent of the oil of *A. calamus* against *Helminthosporium oryzae* (38). Antifungal proteins, haem peroxidases, were purified from the leaves of *A. calamus*. These enzymes inhibited hyphal growth of the phytopathogens such as *Macrophomina phaseolina*, *Fusarium moniliforme* and *Trichosporium vesiculosum* (39). The ethanol extract of *A. calamus* rhizome and a compound isolated from it, (*Z*)-asarone, exhibited strong insecticidal property (40). The mechanism of the tranquilizing action of asarone from *A. calamus* was studied. The sedative effect of asarone was found to depend on the depression of the ergotropic division of the hypothalamus (41). In acute and chronic experiments on mice, rats, cats and rabbits, α-asarone demonstrated diverse biological activities such as tranquilizing, sedative, antiulcer, spasmolytic and antisclerosing (42). However, α-asarone was found

to be mutagenic to *Salmonella typhimurium* TA100 in a concentration dependent manner. Its mutagenicity was comparable to that of induced by aflatoxin (43). A novel lectin showing potent mitogenic activity towards mouse splenocytes and human lymphocytes as well as inhibitory potential towards murine cancer cell lines has been purified from *A. calamus* rhizome (44). *A. calamus* extract decreased the cholesterol biosynthesis in the liver and had potential beneficial effect in atherosclerosis associated with hyperlipidemia (45).

Morchella esculenta

Morchella esculenta (L.) Pers. ex Fr. (Nepali language: *Guchi chyau*; Trade name: *Chau*) belongs to the family Helvellaceae. It is distributed around the world (Europe, Asia and North America) especially in the temperate regions.

Traditional use

It is a delicious food item with alleged aphrodisiac properties.

Chemical constituents

M. esculenta lipids had the following properties: acid no. 3.18, saponification no. 224.4 and iodine no. 107.2. The fatty acids obtained after saponification included linoleic 52.8%, oleic 23.6%, palmitic 14.1%, stearic 5.4% and heptadecanoic 0.4% acids (46). A peptide, γ-L-glutamyl-*cis*-3-amino-L-proline, has been isolated from the cultured mycelium of *M. esculenta* (47). A comparative study of the chemical compounds of *M. esculenta* collected from Japan, Germany and France was done. In all these three samples, the amount of moisture, proteins and lipids were almost same but the Japanese sample contained lower amount of ash than the Germany and France samples. The main fatty acids in all three samples were C16:0 (13%), C18:1 (apprx. 10%) and C18:2 (apprx. 60%). Among the sterols, ergosterol was approximately 35% in the Germany and France samples where as the Japanese sample had about 15%. Ergosta-5,7-dienol (apprx. 36%.) was found in the Germany and France samples. 5'-GMP in the German sample was 5-fold more than in the Japanese sample (48). An amino acid called morchelline has been obtained from a culture broth of *M. esculenta* (49). Another amino acid, *cis*-3-amino-L-proline, was isolated from the growth medium containing mycelia of *M. esculenta* (50). Enzymes belonging to the class γ-glutamyltranspeptidases with the ability to perform hydrolysis and transpeptidation of various γ-glutamyl substrates have partially been purified from the cell-free extract of cultured mycelia of *M. esculenta* (51). Furthermore, fraction containing lipoxygenase activity has partially been purified from an enzymatic extract from *M. esculenta* (52). Polysaccharides named as MEP-SP2 and MEP-SP3 have been obtained from *M. esculenta*. MEP-SP2 with molecular weight

of 23,000 contained four kinds of monosacccharides. These monosacccharides were mannose, glucose, arabinose, and galactose in the mole ratio 1.75:4.13:0.71:0.68. MEP-SP3 has molecular weight of 44,000 and it consisted of six kinds of monosaccharides. They are xylose, glucose, mannose, fructose, arabinose, and galactose in the mole ratio 3.58:14.9:3.85: 1.77:51.3:0.53 (53). From a polar extract of *M. esculenta*, a high molecular weight galactomannan polysaccharide was isolated. It consisted of about 2.0% of the dry fungal material weight and includes mannose (62.9%) and galactose (20.0%) (54). A steroidal derivative, ergosterol peroxide, has been detected in *M. esculenta* (55).

Biological properties

M. esculenta extract was found to be active against *Escherichia coli*, *Bacillus mesentericus* and *Bacillus subtilis* (56). Polysaccharide from *M. esculenta* had strong antibacterial and anti-actinomycete powers (57). The methanol extract (58) as well as ethanol extract (59) of *M. esculenta* demonstrated high antioxidant properties. The galactomannan polysaccharide isolated from *M. esculenta* demonstrated immunostimulatory activity (54). The platelet aggregation inhibitor isolated from the fruiting body of *M.esculenta* has been patented (60). A patent has been issued to skin-lightening cosmetics containing melanin formation inhibitor extracted from cultured *M. esculenta* (61).

Swertia chirayita

Swertia chirayita (Roxb. ex Fleming) Karsten (Nepali language and trade name: *Chiraito*) belong to the family Gentiaceae. It is found in the Himalayan region (Kashmir to Bhutan) and Assam at the elevation range of 1500 to 2500 meter.

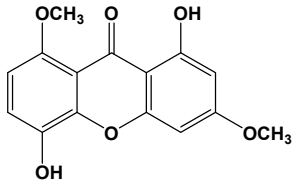
Traditional use

It is used as tonic, febrifuge, stomachic, laxative, anthelmintic, antimalarial, antidiarrhoetic and finds applications in liver disorders as well.

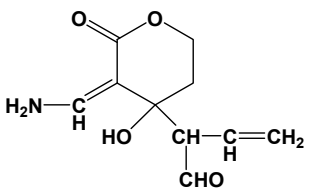
Chemical constituents

Xanthones, seco-iridoid glycosides, triterpenoids and steroids constitute the major constituents of *S. chirayita*. Xanthones such as 1,3,5,8-tetrahydroxyxanthone, 1,3,7,8-tetrahydroxy- xanthone, 1,3,8-trihydroxy-5-methoxyxanthone,1,3- dihydroxy-3,5-dimethoxyxanthone (swerchirin), 1,5,8-trihydroxy-3-methoxyxanthone, 1,8-di-hydroxy-3,7-dimethoxyxanthone, 1-hydroxy-3,5,8-trimethoxyxanthone, 1-hydroxy-3,7,8-trimethoxyxanthone, 1,5 dihydroxy-3,8-dimethoxyxanthone (chiratol), decussatin, mangiferin, mangostin, swertianin, norbellidifolin, bellidifolin, norswertianolin and

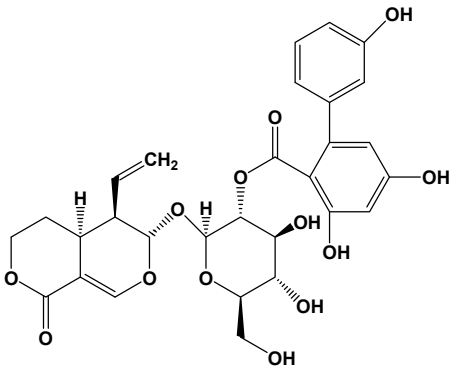
swertianolin have been obtained from *S. chirayita*. Among the isolated seco-iridoid glycosides include amarogentin, amaroswerin, sweroside-2′-*O*-3″,5″-trihydroxy biphenyl-2″ carboxylic acid ester, swerta-7,9(11)-dien-3-*β*-ol, sweroside, gentiopicroside, deacetylcentapicrin and amarogentin. Triterpenoids such as lupeol, oleanolic acid, ursolic acid, β-amyrin, taraxerol, swertanone, swertenol, episwertenol, chiratenol, gammacer-16-en-*β*-ol and alkaloids such as gentianine, gentiocrucine, enicoflavine have also been isolated. Other isolated compounds include steroids such as *β*-sitosterol and *β*-sitosterol–3–*β*-D-glucoside; aromatic acids such as *m*-hydroxybenzoic acid, vanillic acid, 2,5-dihydroxyterephthalic acid and lignan such as syingaresinol (62) (63). *S. chirayita* essential oil contained hexadecanoic acid ethyl ester (19.54%), 4-(phenylmethyl)-pyridine (11.72%), ethyl oleate (7.82%), butylated hydroxytoluene (6.70%), linoleic acid ethyl ester (5.80%), butanedioic acid di-ethyl ester (3.21%) and 3a,6a-dihydro-2(3H,4H)-cyclopenta[b]furanone (2.13%) (64). The structures of representative isolated compounds are written below.



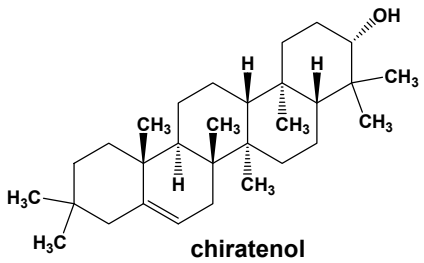
chiratol



enicoflavine



amarogentin



chiratenol

Biological properties

S. chirayita is a well respected medicinal herb of the Himalayan region. It finds applications in the traditional medicinal systems of the Indian subcontinent such as the Ayurveda, Unani and Siddha. Several biological activities have been attributed to *S. chirayita*. They include anticholinergic, anti-inflammatory, hepatoprotective, hypnotic, hypoglycemic (antidiabetic) and laxative (62). *S. chirayita* forms a part of patented traditional Tibetan medicinal formulations such as for treating hyperlipidemia (65), a preparation with antidote effect (66) and for treating liver and bladder diseases (67).

Jurinea dolomiaea

Jurinea dolomiaea Boiss. (Amchi term: *Sila poe*; Nepali language and trade name: *Dhupjadi*) belongs to the family Compositae. It is distributed in Western Asia, Turkey, Iran and the Himalayan region at the elevation range of 3200-3800 meter.

Traditional use

Root juice is taken in case of diarrhea and stomachache. The plant is widely used as incense.

Chemical constituents and biological properties

Chemical and biological studies are lacking in this plant.

Nardostachys grandiflora

Nardostachys grandiflora DC. (Synonym: *Nardostachys jatamansi* DC.) (Amchi term: *Drak poe*; Nepali language and trade name: *Jatamansi*) belongs to the family Valerianaceae. It is available in the Himalayan region (Garhwal to Bhutan), Tibet and west China at the elevation range of 3200 to 5000 meter.

Nardostachys grandiflora

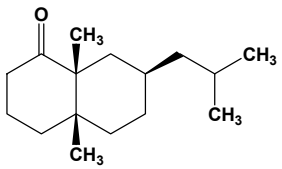
Traditional use

The rhizome decoction is diuretic. It finds application in cases of indigestion, leprosy, fever and constipation. Leaf juices are taken in headache, cold & cough and altitude sickness.

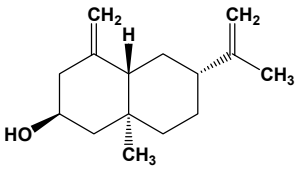
Chemical constituents

In the essential oil of the roots of *N. grandiflora*, five compounds, nardostachnol (9-aristolen-1α-ol), Δ9,10-aristolene, Δ1,10-aristolene, *β*-maaliene and 1,2,9,10-tetradehydroaristolene were identified (68). In the essential oil of the rhizome of *N. jatamansi* purchased in Kathmandu market, fifteen compounds were identified of which thirteen were sesquiterpenes and one each aromatic and coumarin derivatives. Two major constituents in this essential oil were *β*-gurjunene (29.1%) and jatamansone (9.7%) (69). *N. jatamans*i rhizome essential oil from the Indian Himalayas contained nine monoterpenes (1.7%), 25 sesquiterpenes (43.9%) and 7 non-terpenic components (24.4%). The major sesquiterpenes include nardol (10.1%), *α*-selinene (9.2%), *β*-caryophyllene (3.3%), cubebol (2.9%), *α*-gurjunene (2.5%), *γ*-gurjunene (2.3%) and *α*-humulene (2.3%) (70). Sesquiterpenes such as jatamols A and B (71), nardin (72) terpenoid ester, nardostachysin (73), spirojatomol (74), seychellene and seychelane (75)

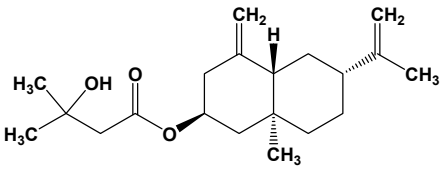
and norseychelanone, α - and β -patchoulenes and patchouli alcohol (76) were also obtained from its rhizome. Furthermore, neolignans and lignans have also been reported from *N. jatamansi* roots (77). The structures of jatamansone, jatamol A, jatamol B and nardin are presented below.



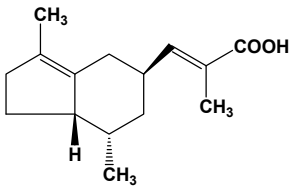
jatamansone



jatamol A



jatamol B



nardin

Biological properties

N. jatamansi rhizome essential oil is fungistatic (78), antimicrobial (79) and nematicidal (80). *N. jatamansi* rhizome is shown to be hepatoprotective (81). It also possessed protective effect in the rat cerebral ischemia (82). The ethanol extract of whole plant of *Nardostachys jatamansi* increased HDL-cholesterol/total cholesterol ratio and decreased total cholesterol/phospholipids ratio (83). *N. jatamansi* helped improve learning and memory in rats (84). *N. jatamansi* was found to play cytoprotective role in doxorubicin induced cardiac damaged rats (85). The ethanol extract of *N. jatamansi* displayed cytotoxic activity (IC_{50} < 30μg/mL) against lung and prostate cancer cell lines (86). *N. jatamansi* showed antiarrhythmic activity (87). Valeranone, a compound isolated from *N. jatamansi* prolonged barbiturate anesthesia, inhibited electroshock convulsions and potentiated the hypothermic effects of reserpine in mice and rats. It also contained antiulcerogenic activity and a weak hypotensive effect (88). The ethanol extract of *N. jatamansi* roots has been found to be helpful in attenuating 6-hydroxydopamine-induced parkinsonism in rats (89). The ethanol extract of *N. jatamansi* produced significant antidepressant-like effect in Swiss young albino mice in both tail suspension and forced swim tests (90). Jatamansone, a sesquiterpene obtained from *N. jatamansi*, is shown to have antiarrhythmic and anticonvulsant (91) as well as tranquillizing (92) activities. The essential oil obtained from *N. grandiflora* inhibited mycelial growth of *Alernaria brassicicola* (93).

Pistacia khinjuk

Pistacia khinjuk Stocks (Nepali language and trade name: *Kakadsinghi*) belongs to the family Anacardiaceae. It is distributed in Iran, Turkey, Baluchistan, Afghanistan, the Himalayan region (Kashmir to Nepal) and Myanmar at the elevation range up to 2400 meter.

Traditional use

It works as tonic and expectorant. It has been used in cough, phthisis, fever and asthma. It is fried in ghee and given to dysentery patients.

Chemical constituents

In the essential oil obtained from the gum of *P. khinjuk*, α-pinene (61.13%) was the principal constituent followed by myrcene (8.28%), β-pinene (2.51%) *p*-cymene (2.50%), 3-carene (1.36%), linalool (2.76%), and β-caryophyllene (1.95%). Other minor terpenes such as α-thujene, camphene, α-fenchene, sabinene, α-phallendrene, β-phallendrene, limonene, cineol, fenchone, borneol, and α-terpineol were also detected (94). Its leaves essential oil contained only monoterpene alcohols and was devoid of sesquiterpenes (95). The fruit essential oil contained 34 components of which *cis*-ocimene (24%), α-pinene (17.9%), myrcene (14%) and *trans*-ocimene (8%) were the major constituents (96). Hydrocarbons (0.9%), wax esters (1.3%), triglycerides (62.3%), free fatty acids (4.9%), 1:3-diglycerides (15.6%), 1:2-diglycerides (7.7%), 2-monoglycerides (4.0%) and 1-monoglycerides (3.3%) were found in *P. khinjuk* lipids (97). Flavonoid glycosides such as quercetin-3-glucoside, quercetin-3-rutinoside, myricetin-3-glucoside, myricetin-3-galactoside and myricetin-3-rutinoside have been detected in *P. khinjuk* (98).

Biological properties

Studies as regards to the biological properties of this plant are lacking.

Neopicrorhiza scrophulariiflora

Neopicrorhiza scrophulariiflora (Pennell) D.Y. Hong (Synonym: *Picrorhiza scrophulariiflora* Pennell) (Amchi term: *Hong len*; Nepali language and trade name: *Kutki*) belongs to the family Scrophulariaceae. It is distributed in Nepal, Bhutan, China, North India and North Myanmar at the elevation range of 3500 to 4800 meter.

Traditional use

The root paste is administered in fever in case of fever, gastritis, intestinal pain, cold and cough, headache, eye irritations and bile disorders.

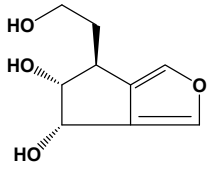
Neopicrorhiza scrophulariiflora

Chemical constituents

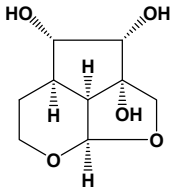
Major isolated compounds from this plant fall in the categories of iridoids, cucurbitacin glycosides and phenyl ethanoid and propanoids. A cucurbitacin glycoside 2*β*-glucopyranosyloxy-3, 16, 20, 22-tetrahydroxy-9-methyl-19-norlanosta-5, 24-diene, together with three iridoid glycosides, amphicoside (picroside-II), catalpol, aucubin and a phenol glycoside, androsin were isolated from the roots of *P. scrophulariiflora* (99). The underground parts of *P. scrophulariiflora* afforded three phenylethanoid glycosides, scrosides A, B and C and an iridoid glycoside, picroside IV (100). Non-glycosidic iridoids such as piscrocins A, B and C (101) as well as piscrocins D, E, F and G (102) have also been obtained from this plant. Two iridoid glucosides with 3,4-dihydrocatalpol skeleton, piscrosides A and B were obtained from *Picrorhiza scrophulariiflora* (103). Further isolated iridoid glucosides include picrorosides A, B and C (101). Phenylethanoid and phenolic glycosides such as 2-(3,4-dihydroxyphenyl)-ethyl-*O*-*β*-D-glucopyranoside, plantainoside, scroside A, scroside B, scroside D, piceoside, 6-*O*-feruloyl-*β*-D-glucopyranoside and 2-(3-hydroxy-4-methoxyphenyl)-ethyl-*O*-*β*-D-glucopyranosyl(1→3)-*β*-D-glucopyranos ide have also been isolated from *P. scrophulariiflora* roots (104). From the stems of *P. scrophulariiflora*, three phenyl glycosides, scrophenoside A, B, and C and two phenylethyl glycosides, scroside D and scroside E were obtained (105). A phenyl glycoside, scrophenoside D and a phenylethyl glycoside, scroside F have also been obtained from *P. scrophulariiflora* (106). Among the isolated cucurbitacin glycosides include 2-*O*-*β*-D-glucopyranosyl-3,16,20,25-tetrahydroxy-9-methyl-19-norlanosta-5,23-diene-22-one, 2-*O*-*β*-D-glucopyranosyl-3,16,20-trihydroxy-25-acetoxy-9-methyl-19-norlanosta-5,23- diene- 22-one and 2-*O*-*β*-D-glucopyranosyl-4,4,9,14-tetramethyl-19-norpregn-5-en-20-one (107). The underground parts of *P. scrophulariiflora* has furnished three caffeoyl glycosides, scrocaffesides A, B and C together with two caffeic acid derivatives, 4-*O*-*β*-D-glucopyranosyl caffeic acid and 4-methoxycaffeic acid (108). The structures of piscrocin A, piscrocin D, picroroside I and scroside A are presented.

Biological properties

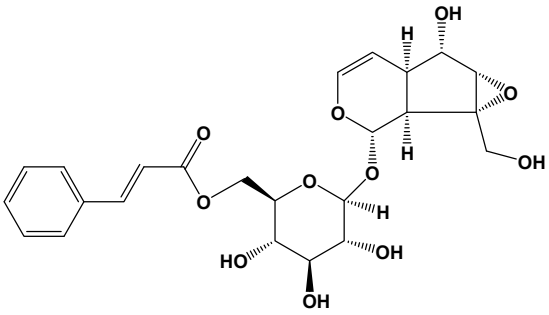
P. scrophulariiflora rhizome extracts are described as having immunomodulatory and anti-inflammatory activities (109). Total glycosides present in *P. scrophulariiflora* represented the active ingredient responsible for the antioxidant effect. These glycosides had the potentiality to protect mesangial cells against oxidative stress induced by high glucose (110). The methanol extract of *P. scrophulariiflor*a possessed superior nerve growth factor-potentiating activity (111). Picrosides I and II isolated from its rhizome were found to be nerve growth factor-potentiating compounds (112).The iridoids isolated from *N. scrophulariiflora* had hepatoprotective activities (102). Picroside II protected hepatocytes against injury and prevented hepatocytes from apoptosis (113). Scroside D, 2-(3,4-dihydroxyphenyl)-ethyl-*O*-*β*-D-glucopyranoside and plantainoside D were found to be potent antioxidant (104). The compound plantainoside D was determined to be a potential candidate agent for protecting cardiotoxicity in adriamycin-exposed patients (114). Two cucurbitacin aglycons, picracin and deacetylpicracin, obtained from *N. scrophulariiflora* brought about inhibition of mitogen-induced T-lymphocyte proliferation at an IC_{50} value of 1 μM (115).



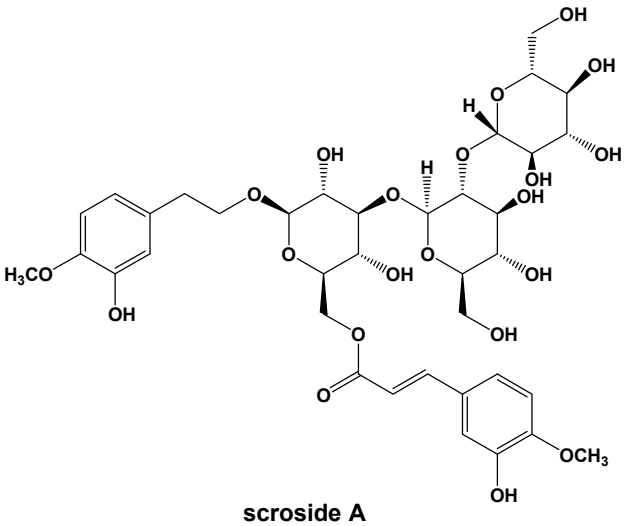
piscrocin A



piscrocin D



picroside I



scroside A

Juglans regia

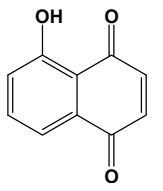
Juglans regia L. (Amchi term: *Tar ka*; Nepali language: *Okhar*) belongs to the family Juglandaceae. It is found in China, South East Asia, the Himalayan region and South East Europe at the elevation range of 500 to 4000 meter.

Traditional use

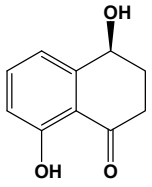
Bark paste is useful in arthritis, skin diseases and toothache. Bark paste is also beneficial for the hair growth. Seed coat is used for healing wounds.

Chemical constituents

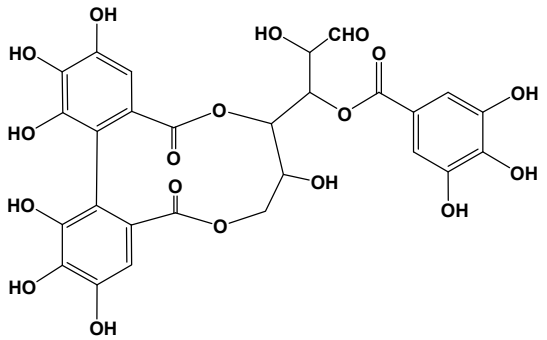
From the bark of *J. ragia* L. var *orientalis*, glucose, mesoinositol, quercetin, quercitrin, and l-sakuranetin were obtained (116). From its stem bark, juglone, betulinic acid, regiolone and *β*-sitosterol have been isolated (117). Its seeds have afforded ellagitannins, glansrins A–C, together with other hydrolysable tannins (118).The hydrolysable tannins of 70% acetone extract of the seeds were identified as gemin D, casuariin, pedunculagin, tellimagrandin I, rugosin F and heterophylliin D (119). The major fatty acids found in *J. regia* were identified as linoleic (18:2n-6), α-linolenic (18:3n-3), oleic (18:1n-9), palmitic (16:0) and stearic acid (18:0). γ-Tocopherol was the main tocopherol homolog present followed by δ- and α-tocopherols. Tocopherols, particularly the γ-tocopherol, contributed mostly to antioxidant activities of *J. regia* (120). Cyclic diarylheptanoids juglanin A and juglanin B were also obtained from the percarp of *J. regia* (121). The structures of representative isolated compounds are presented below.



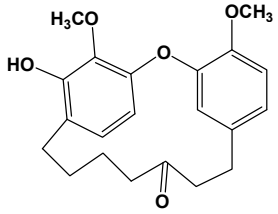
juglone



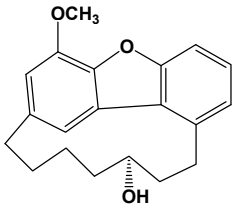
regiolone



gemin D



juglanin A



juglanin B

Biological properties

The trunk bark extract of *J. regia* showed high antioxidant, radical scavenging and anti-microbial properities (122). Its leaves too had strong antioxidant activity (123). Aqueous, water-alcohol, and alcoholic extracts of the nuts of *J. regia* brought about the contraction of the small intestines of guinea pigs and rats. The contraction was inhibited by atropine and papaverine (124). *J. regia* is also shown to possess hepatoprotective activity (125). Juglone, one of the components of *J. regia*, is a naphthaquinone and naphthoquinones have significant pharmacological properties such as cytotoxic, antibacterial, antifungal, antiviral, insecticidal, anti-inflammatory and antipyretic (126).

Rheum australe

Rheum australe D. Don (Synonym: *Rheum emodi* Wall. ex Meisn.) (Amchi term: *Chu tsa*; Nepali language and trade name: *Padamchal*) belong to the family Polygonaceae. It is found in the Himalayan region and south Tibet at the elevation range of 3200 to 4200 meter.

Rheum australe

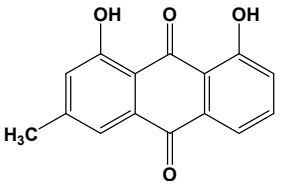
Traditional use

Juices from the shoot portion of the plant are taken for cold & cough chest pain, diarrhea, dysentery and swelling. Root paste is used in case of strain and fractures. Leaves and petiole are considered antihelminthic and appetizer.

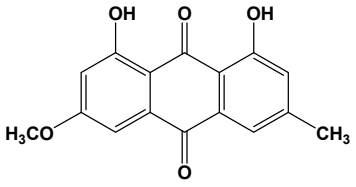
Chemical constituents

Anthraquinones such as rhein, physcion, aloe-emodin and chrysophanol (127) 6-methylrhein and 6-methyl-aloe-emodin (128) have been obtained from *R. emodi* rhizomes. The rhizome has also afforded two oxanthrone esters, revandchinone-1, revandchinone-2, an anthraquinone ether revandchinone-3 and a oxanthrone ether, revandchinone-4 (129). A sulfated emodin glucoside, emodin-8-*O*-*β*-D-glucopyranosyl-6-O-sulfate together with two auronols, carpusin and maesopsin, were isolated from the roots of *R. emodi* (130). Its roots afforded anthrone C-glucosides such as 10-hydroxy-cascaroside C and 10-hydroxycascaroside D as well as chrysaloin 1-*O*-*β*-D-glucopyranoside and 8-*O*-*β*-D-(6'-*O*-acetyl)glucopyranosylchrysophanol. In addition, cascaroside C, cascaroside D and cassialoin were also isolated (131). Other isolated compounds include *β*-sitosterol, piceatannol , d-catechin, daucosterol , piceatannol-4'-*O*-*β*- glucopyranoside, piceatannol-4'-*O*-*β*-D-(6"-O-galloyl)-

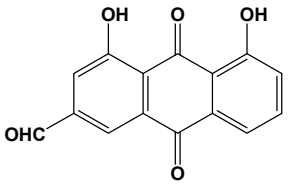
glucopyranoside, emodin-8-*O*-*β*-D- glucopyranoside and chrysophanol-8-*O*-*β*-D--glucopyranoside (132). *R. emodi* rhizome has further afforded two more anthraquinone derivatives named as rheinal and rhein-11-*O*-*β*-D-glucoside (133). The structures of representative isolated compounds are presented below.



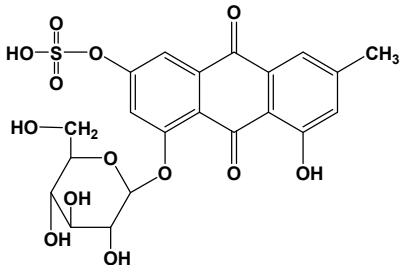
chrysophanol



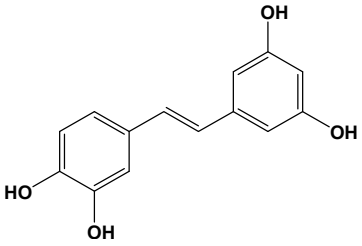
physcion



rheinal



emodin-8-*O*-β-D-glucopyranosyl-6-*O*-sulfate



piceatannol

Biological properties

The ethanol and benzene extracts of *R. emodi* inhibited *Helicobacter pylori* in both *in vitro* and *in vivo* experiments (134). Chrysophanol, physcion, rhein and emodin isolated from *R. emodi* are shown to possess antifungal properties (127). Revandchinone-1 and revandchinone-3 obtained from *R. emodi* demonstrated modest degree of antibacterial activity. Revandchinone-4 was found to be superior antibacterial substance as compared to revandchinone-1 and revandchinone-3. A moderate level of antifungal activity was shown by all three isolated compounds revandchinone-1, revandchinone-2 and revandchinone-3 (129). The auronols from the plant such as carpusin and maesopsin were potent antioxidant in the DPPH assay (130). Several biologically active preparations from *Rheum* such as antivirally active fractions (135), antiinflammatorily active fractions (136) and antioxidant fractions (137) have been patented. *R. emodi* forms a part of Unani herbal composition for the treatment of viral hepatitis and jaundice (138). Two patents on manufacture and application of *R. emodi* extraction solution and extract powder for improving motor ability and preventing anoxia are available (139), (140).

Pinus wallichiana

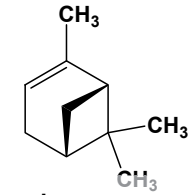
Pinus wallichiana A. B. Jacks. (Amchi term: *Thesing*, Doma; Nepali language: *Gobre salla*, Trade name: *Salla simta*) belongs to the family Pinaceae. It is found in Afghanistan, the Himalayan region and South East Tibet at around 4300 meter.

Traditional use

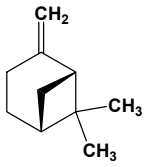
The plant resin is used in case of stomachache and body pain. It finds application in snake bite as well.

Chemical constituents

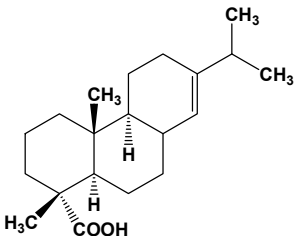
P. wallichiana yielded rosin (84%) and turpentine oil (16%). Turpentine oil contained 89% α-pinene and 4.4% β-pinene as major constituents and rosin contained abietic acid (70%) (141). Furthermore, isomers of undecane, dodecane and tridecane and some sesquiterpenes as minor components were detected in turpentile oil where as rosin contained isopimaric acid and lambertianic acid as well (142). Its bark contains 12.2% tannin (143). The structures of representative isolated compounds are presented below.



α-pinene



β-pinene



abietic acid

Biological properties

It forms a part of patented skin preparation formulation with anti-wrinkling properties (144).

Paris polyphylla

Paris polyphylla Sm. (Nepali language and trade name: *Satuwa*) belongs to the family Liliacea. It is distributed in Bhutan, India, Laos, Myanmar, Nepal, Sikkim, Thailand, Vietnam and China at the elevation range of 100 to 3500 meter.

Paris polyphylla

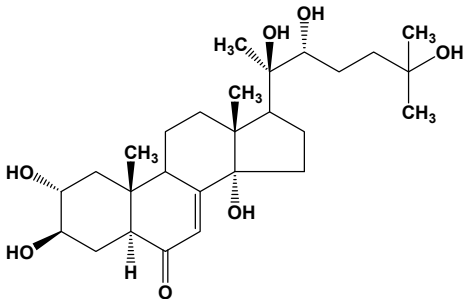
Traditional use

The root decoction is anthelmintic and antiseptic. The root paste is used to heal cuts and wounds. It is also used as the antidote for aconitum poisoning.

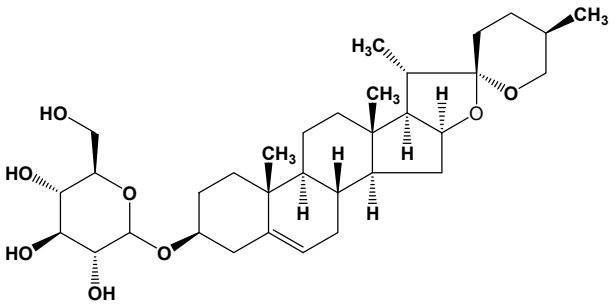
Chemical constituents

P. polyphylla is a rich source of diverse steroid saponins. The plant has been identified as a new

source of diosgenin (145). A phytoecdysone called paristerone has been isolated from the tuber of *P. polyphylla* (146). *P. polyphylla* tubers contained saponins such as pariphyllin, diosgenin-3-*O*-α-L-rhamnopyranosyl(1 → 4)-α-L-arabinofuranosyl-(1 → 3)-β-D-glucopyranoside (147), diosgenin 3-*O*-α-L-rhamopyranosyl-(1 → 2)-[α-L-arabinofuranosyl-(1 → 4)]-β-D-glucopyranoside, diosgenin 3*O*-αL-rhamnopyranosyl-(1 →4)-α-L-rhamnopyranosyl-(1 → 4)-[α-L-rhamnopyranosyl-(1 → 2)]-β-D-glucopyranoside pregna-5,16-dien-3β-ol-20-one 3-*O*-β-chacotrioside, dioscin (diosgenin 3-O-β-chacotrioside) (148) pariphyllin A and B (149) polyphyllin A, B, C, D, E, F, and G, H (150) (23S, 25S)-3β, 23, 27-trihydoxyspirost-5-en-3-*O*-β-D-glucopyranosyl-(1→6)-β-D-glucopyranoside, Paris saponin I, Paris saponin II, (25R) diosgenin-3-*O*-β-D-glucopyranoside, (25R) diosgenin-3-*O*-α-L-arabinofuranosyl(1→4)-β-D-glucopyranoside, (25R) diosgenin--3-*O*-α-L-rhamnopyranosyl(1→2)-β-D-glucopyranoside, (25R) diosgenin-3-*O*-α-L--glucopyranosyl(1→3)[α-L-rhamnopyranosyl(1→2)]-β-D-glucopyranoside , (25R) pennogenin-3-*O*-α-L-arabinofuranosyl(1→4)[α-L-rhamnopyranosyl(1→2)]-β-D-glucopyranoside (151). The structures of paristerone and polyphyllin A are presented below.



paristerone



polyphyllin A

Biological properties

P. polyphylla contains antioxidant activity (152). *P. polyphylla* var. *chinensis* and *P. polyphylla* var. *yunnanensis* had strong analgesic action. *P. polyphylla* var. chinensis was also found to be potent sedative (153). *P. polyphylla* aqueous extract showed a moderate antimutagenic activity against picrolonic acid- and benzo[a]pyrene-induced mutations (154). *P. polyphylla* extract is shown to contain spermicidal activity in rat and human sperm (155). The methanol extract of the rhizomes of *P. polyphylla* Sm. var. *yunnanensis* was found to potently inhibit ethanol-induced gastric lesions in rats. Based on bioassay directed fractionation, four spirostanol-type steroid saponins were isolated and the isolated saponins strongly inhibited gastric lesions induced by ethanol and

indomethacin (156). The anti-tumor saponins have been isolated from the rhizome of *P. polyphylla* var. *yunnanensis* (157). Polyphyllin D isolated from *P. pollyphyla* has a strong apoptosis inducer in drug-resistant HepG2 cells making it a potent anticancer agent (158). Polyphyllin D was also found to inhibit human breast cancer cells (159). *P. polyphylla* rhizomes have afforded four diosgenin type saponins which were found to be tyrosinase inhibitors as well as antileishmanial agents (160). Furthermore, immuno-stimulating diosgenyl saponins have also been isolated from *P. polyphylla* (161).

Asparagus racemosus

Asparagus racemosus Willd. (Nepali language and trade name: *Satawari*, *Kurilo*) belongs to the family Liliaceae. It is found in the Himalayan region, India, Malaysia, Australia and Africa. at the elevation range of 600 to 2100 meter.

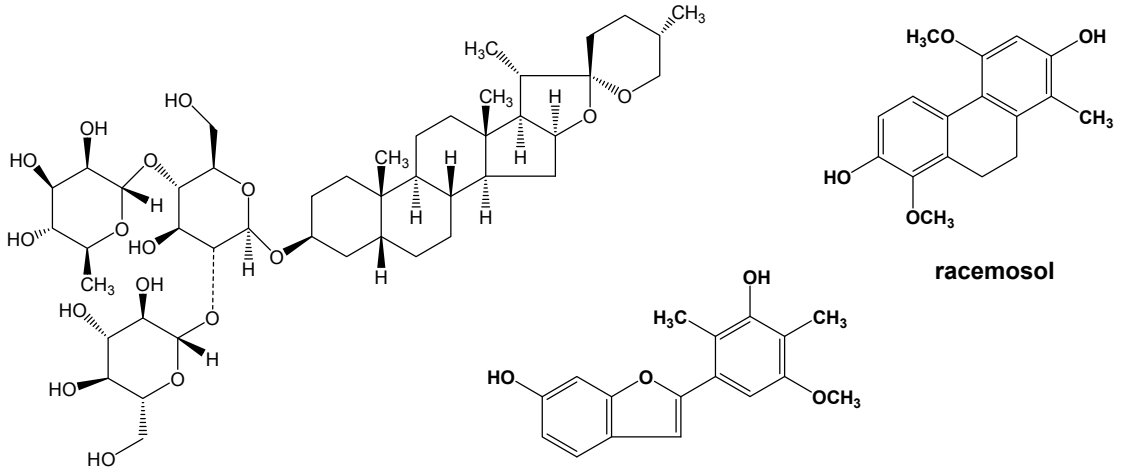
Traditional use

It is used as demulcent, diuretic, aphrodisiac, antispasmodic, antidiarrhoeal, galactogogue and in rheumatism.

Chemical constituents

Among the isolated compounds from *A. racemosus*, bioactive steroidal saponins dominate. From its roots, steroidal saponins such as shatavarin I (162), shatavarin IV (163), shatavarin V (164), shatavarins VI–X (165) and immunoside (166) have been isolated. *A. racemosus* fruits further afforded three more steroidal saponins, racemosides A, B and C (167). However, the original structures of shatavarin I and shatavarin IV were found not to be correct and were revised (168). A polycyclic pyrrolizidine alkaloid, asparagamine A, was also obtained from its roots (169). Glycosides of quercetin, rutin, and hyperoside have been detected in the flowers and fruit of *A. racemosus*. Flowers contained free quercetin. Anthocyanins such as cyanidin-3-galactoside and cyanidin-3-glucorhamnoside were found in the ripe fruits (170). A 9,10-dihydrophenanthrene derivative named racemosol (171) and an isoflavone, 8-methoxy-5,6,4′-trihydroxyisoflavone 7-O-β-glucopyranoside (172) are two other compounds obtained from the roots of *A. racemosus*. Its leaves afforded a flavone glycoside which was identified as flavone glycoside, 5-hydroxy 3,6,4'-trimethoxy-7-*O*-β-D-glucopyranosyl [1$\rightarrow$4]-*O*-α-D-xylopyranoside (173). One another compound, racemofuran, was also found in its roots (174). One disaccharide, 3-*O*-β-D-glucopyranosyl-D-mannopyranosealong with two monosaccharides, D-glucose and D-mannose have been obtained from the ethanol extract of A. racemosus roots(175). Diosgenin is said to be found in the leaves of *A. racemosus* (176). The

structures of shatavarin IV, racemosol and racemofuran are presented below.



shatavarin IV

racemosol

racemofuran

Biological properties

Host of beneficial biological properties are attributed to *A. racemosus*. Methanol extract of *A. racemosus* roots possessed antibacterial property (177). The roots were found to be antioxidant. An antioxidant compound, racemofuran, was identified in the roots (171). Furthermore, *A. racemosus* displayed potent antioxidant properties *in vitro* on mitochondrial membranes of rat liver (178). *A. racemosus* root is shown to be antihelmintic (179), anti-diarrhoeal (180) and antilithiatic (181). *A. racemosus* was effective in reducing gastric ulcer in indomethacin-treated gastric ulcerative rats. The effect was comparable with that of the standard drug ranitidine (182). Methanol extract of *A. racemosus* demonstrated significant antidepressant-like activity (183). Saponin glycosides (184) as well as an alkaloid asparagamine A (185) obtained from *A. racemosus* displayed antioxitocin activity. The plant is found to act as a galactagogue (186) and has an oestrogenic effect on the pregnant female albino rats mammary gland and genital organs (187). The aqueous extract of *A. racemosus* prevented hepatocarcinogenesis induced by treatment with diethylnitrosamine (188). Asparagamine A , an isolate from *A. racemosus*, exhibited antitumor activity against human gastric carcinoma (189). *A.racemosus* is shown to contain the immunomodulant and immunoadjuvant potentialities (190) (191). *A. racemosus* root extracts were found to have wide-ranging stimulatory effects on physiology of insulinotropic pathways displaying its prospect for diabetes treatment (192). Furthermore, it exhibited potent antioxidant potential in diabetic conditions (193). The plant is found to be anti-inflammatory (194), antiallergic (195) and useful in dyspepsia (196). Two review

articles on *A. racemosus* are worth reading (197) (198).

Valeriana jatamansii

Valeriana jatamansii Jones (Synonym: *Valeriana wallichii* DC.) (Amchi term: *Drak poe*; Nepali language: *Sugandhawal*) belongs to the family Valerianaceae. It is distributed in Afghanistan, the Himalayan region (Kashmir to Bhutan), Assam, Tibet, Myanmar and Western Central China at the elevation range of 1500 to 3000 meter.

Traditional use

Rhizome paste finds application in headache, sore throat, indigestion and people suffering from shock. Shoot juice is applied in case of eye ailments.

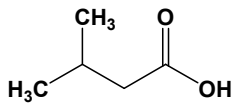
Chemical constituents

V. jatamansii volatile oil is found to contain seventy two compounds. Among them, sixty one compounds were identified of which major components were isovaleric acid (52.95%), patchouli alcohol (18.20%), 3-methyl pentanoic acid (6.89%), 1-ethyl-4,4-dimethyl-cyclohex-2-en-1-ol (3.27%) and neocembrene A (2.12%) (199). *V. wallichi*i DC leaf essential oil from Northwestern Himalayas had 20 components of which 3-methylvaleric acid (26.5%) and maaliol (39.2%) were the principal constituents. Maaliol (64.3%) and *β*-gurjunene (7.2%) were the main constituents in its root essential oil (200). Valepotriates have been detected in the aerial parts of *V. jatamansii* (201). Iridoids such as 1-homoacevaltrate, 11-homohydroxyldihydrovaltrate, 10-acetoxy-1-homovaltrate hydrin and 10-acetoxy-1-acevaltrate hydrin together with valtrate, isovaltrate, homo- valtrate, acevaltrate, dihomovaltrate, didrovaltrate, 1-homodidrovaltrate, 9- acetylhydroxyldihydrovaltrate, 10-isovaleroxyvaltrate hydrin and 10-isovaleroxydiavaltrate hydrin have been obtained from its rhizome (202). Sesqiterpenes like valerianananoids A, B and C were also isolated from *V. jatamansii* rhizome (203). From the rhizomes and roots of *V. jatamansii*, flavone glycosides, acacetin7-*O*-*β*-sophoroside and acacetin 7-*O*-(6 " -*O*-*α*-l-rhamnopyranosyl)-*β*-sophoroside have been isolated (204). The structures of its volatile oil components well as valtrate are given below.

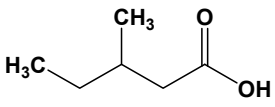
Biological properties

V. wallichii DC essential oil contained potent antifungal efficacy (205). The essential oil was also found to be antibacterial (206). The aqueous extract of *V. jatamansii* together with pentobarbital sodium enhanced sedative and hypnotic effect and inhibited the spontaneous activity in mice as well as antagonized convulsive action induced by thiosemicarbazide (TSZ) (207). *V. jatamansi* forms part of several Chinese medicinal formulations which have been patented. These include formulations for treating cancer

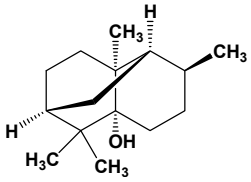
(208), a medicated liquor for topically treating rheumatic arthralgia, pain and blood stasis due to traumatic injury, traumatic hemorrhage, sprain, pains in bones and muscles, rheumatic arthritis, and soft tissue contusion (209), a composition for externally treating rheumatalgia, arthralgia, myalgia, traumatic injury, rheumatism and rheumatoid arthritis (210) and a composition for treating acquired immunodeficiency syndrome (211). It is also a component of perfume preparations (212), (213). From *V. wallichii*, 6-methylapigenin was isolated which functioned as a competitive ligand for the brain GABA(A) receptors (214).



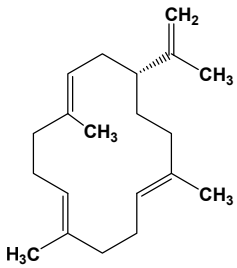
isovaleric acid



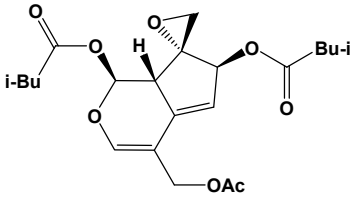
3-methylpentanoic acid



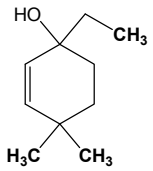
patchouli alcohol



neocembrine A



valtrate



1-ethyl-4,4-dimethyl-cyclohex-2-en-1-ol

In conclusion, it can be said that the Dolpa medicinal plants show wide variety of the biological properties and complex array of the chemical structure diversity. Meticulous research and development works followed by bioprospecting endeavor are keys to exploit the valuable medicinal properties of these natural resources.

Acknowledgement

Mr. Kuber Jung Malla for the photographs of *Nardostachys grandiflora*, *Picrorhiza scrophulariiflora*, *Rheum australe* and *Paris polyphylla* is gratefully acknowledged.

References

1. Lama Y. C., Ghimire S. K., Aumeeruddy Thomas Y., Medicinal Plants of Dolpo: Amchi's Knowledge and Conservation. People and Plants Initiative, WWF Nepal Program, Nepal, **2001**.
2. Kunwar R. M., Adhikari N., *Lyonia*, **2005**, *8*, 43–49.
3. Kunwar R. M., Nepal B. K., Kshhetri H. B., Rai S. K., Bussmann R. W., *J Ethnobiol Ethnomed.*, **2006**, doi:10.1186/1746-4269–2–27.
4. Ghimire, S.K., Lama Y. L., Gurung T. N., Aumeeruddy Thomas Y., Conservation of Plant Resources, Community Development and Training in Applied Ethnobotany at Shey Phoksundo National Park and its Buffer Zone, Dolpa, WWF-Nepal Program, People and Plants Initiative, Third Year

Technical Report, WWF, Nepal, **2001**.
5. Aumeeruddy Thomas Y., Medicinal Plant Conservation, Newsletter of the Medicinal Plant Specialist Group of the IUCN Species Survival Commission, **2000**, *7*, 8–11.
6. IUCN- The World Conservation Union, National Register of Medicinal Plants, IUCN, Kathmandu, Nepal, **2000**.
7. Press J. R., Shrestha K. K., Sutton D. A., Annoted Checklist of the Flowering Plants of Nepal, National History Museum, London and Central Departmant of Botany, Tribhuvan University, Kathmandu, Nepal, **2001**.
8. Adityachaudhury N., Chowdhury A., Das A. K., *Ind J Chem.*, **1974**, *12*, 1327.
9. Saharia G. S., Sharma P., Sharma B. R., *Ind J Forestry.*, **1979**, *2*, 59–60.
10. Sood S., Gupta B. D., Banerjee S. K., *Ind J Pharm Sci.*, **1978**, *40*, 98.
11. Sood S., Chopra, M. M., Jamwal R. K., *Ind Perfumer.*, **1978**, *22*, 127–129.
12. Tewari M., Mathela C. S., *Ind Perfumer.*, **2003**, *47*, 343–345.
13. Dev V., Oka M., Mathela C. S., Murari N. D., Stevens T. H., *J Nat Prod.*, **1984**, *47*, 904–905.
14. Kumamoto H., Patent *JP 06116204 A,* **19940426**.
15. Fujita S., Enomoto Y., Suemitsu R., Fujita Y., *Yakugaku Zasshi*, **1971**, *91*, 571–574.
16. Todorova M. N., Ognyanov I. V., Shatar S., *J Essent Oil Res.*, **1995**, *7*, 191–193.
17. Nigam M. C., Ahmad A., Misra L. N., *Ind Perfumer.*, **1990**, *34*, 282–285.
18. Raina V. K., Srivastava S. K., Syamasunder K. V., *Flavour & Fragrance J.*, **2003**, *18*, 18–20.
19. Ozcan M., Akgul A., Chalchat J. C., *J Essent Oil Res.*, **2002**, *14*, 366–368.
20. Gong X., Dian L., Zhang L., Cai C., *Zhongguo Yaofang*, **2007**, *18*, 176–178.
21. Garneau F-X., Collin G., Gagnon H., Belanger A., Lavoie S., Savard N., Pichette A., *J Essent Oil Res.*, **2008**, *20*, 250–254.
22. Radusiene J., Peciulyte D., Judzentiene A., *Proceedings of the International Symposium on Plants as Food and Medicine*, *2006*, **2008,** 35-42**.**
23. Radusiene J., Judzentiene A., Peciulyte D., Janulis V., *Plant Genetic Resources*, **2007**, *5*, 37–44.
24. Iguchi M., Niwa M., Nishiyama A., Yamamura S., *Tetrahedron Lett.*, **1973**, *29*, 2759–2762.
25. Niwa M., Nishiyama A., Iguchi M., Yamamura S., *Bull Chem Soc Jap.*, **1975**, *48*, 2930–2934.
26. Wu L. J., Sun L. L., Li M., Yang H., Jiang Z. R., Lu Y., Tian Z., Zheng Q.,Miyase T., Uneo A., *Yakugaku Zasshi*, **1994**, *114*, 182–185.
27. Tkachev A. V., Gur'ev A. M., Yusubov M. S., *Chem Nat Compd.*, **2006**, *42*, 696–698.
28. Patra A., Mitra A. K., *Ind J Chem.*, **1979**, *17B*, 412–414.
29. El'yashevich E. G., Drozd G. A., Koreshchuk K. E., Bezuglaya N. I., Manych V. I., Shestak L. I., *Khimiya Prirodnykh Soedinenii*, **1974**, *10*, 94.
30. Madan B. R., Arora R. B., Kapila K., *Archives Internationales de Pharmacodynamie et de Therapie*, **1960**, *124*, 201–211.
31. Bose B. C., Vijayvargirja R., Saifi A. Q., Sharma S. K., *J Amer Pharm Assoc.*, **1960**, *49*, 32–34.
32. Baxter R. M., Dandiya P. C., Kandel S. I., Okany A., Walker G. C., *Nature*, **1960**, *185*, 466–467.
33. Maj J., Malec D., Lastowski Z., *Acta Poloniae Pharmaceutica*, **1966**, *23*, 477–482.
34. Maj J., Lastowski Z., Lukowski K., *Dissertationes Pharmaceuticae*, **1965**, *17*, 157–161.
35. Parab R. S., Mengi S. A*., Fitoterapia*, **2002**, *73*, 451–455.
36. Mehrotra S., Mishra K. P., Maurya R., Srimal R. C., Yadav V. S., Pandey R., Singh V. K., *Int immunopharmacol.*, **2003**, *3*, 53–61.
37. Panchal G.M., Venkatakrishna-Bhatt H., Doctor R. B., Vajpayee S., *Ind J Experimental Bio.*, **1989**, *27*, 561−567.
38. Saxena D. B., Tomar S. S., Singh R. P., *Ind Perfumer.*, **1990**, *34*, 199–203.
39. Ghosh M., *Annals of Botany*, **2006**, 98, 1145–1153.
40. Yao Y., Cai Y., Yang C., Xue, Dong H., *Insect Science*, **2008**, *15*, 229–236.
41. Menon M. K., Dandiya P. C., *J Pharm Pharmacol.*, **1967**, *19*, 170–175.
42. Belova L. F, Alibekov S. D., Baginskaia A. I., Sokolov S. I., Pokrovskaia G. V., *Farmakologiia i toksikologiia*, **1985**, *48*, 17–20.
43. Jin Z., Qin W., Chen X., *Zhejiang Yike Daxue Xuebao*, **1982**, *11*, 1–3.
44. Bains J. S., Dhuna V., Singh J.,Kamboj S. S., Nijjar K. K., Agrewala J. N., *International Immunopharmacology*, **2005**, *5*, 1470–1478.
45. D'Souza T., Mengi S. A., Hassarajani S., Chattopadhayay S., *Ind J Pharmacol.*, **2007**, *39*, 196–200.
46. Ivanov S. A., Bliznakova L., *Natura* (Plovdiv, Bulgaria), **1967**, *1*, 39–40.

47. Moriguchi M., Kimura K., Hatanaka S., *Transactions of the Mycological Society of Japan*, **1983**, *24*, 191–195.
48. Yokokawa H., Ohura Y., *Tachikawa Tandai Kiyo*, **1990**, *23*, 29–33.
49. Tsubaki K., Hatanaka S., Patent *JP 46037874 B,* **19711108**.
50. Moriguchi M., Sada S., Hatanaka S., *App Environ Microbiol.*, **1979**, *38*, 1018–1019.
51. Moriguchi M., Yamada M., Suenaga S., Tanaka H., Wakasugi A., Hatanaka S., *Archv Microbiol.*, **1986**, *144*, 15–19.
52. Bisakowski B., Atwal A. S., Kermasha S., *Process Biochem* (Oxford), **2000**, *36*, 1–7.
53. Wei Y., Zhang T., Zhang S., Liu Q., *Zhiwu Ziyuan Yu Huanjing Xuebao*, **2000**, *9*, 14–17.
54. Duncan C. J. G., Pugh N., Pasco D. S., Ross S. A., *J Agric Food Chem.*, **2002**, *50*, 5683–5685.
55. Krzyczkowski W., Malinowska E., Suchocki P., Kleps J., Olejnik M., Herold F., *Food Chem.*, **2009**, *113*, 351–355.
56. Iliev S. V., Kostadinov I. Z., Kenanov E. G., *Natura* (Plovdiv, Bulgaria), **1967**, *1*, 53–55.
57. Long Z., Ji Q., Zhou H., *Shizhen Guoyi Guoyao*, **2006**, *17*, 902–903.
58. Mau J–L., Chang C–N, Huang S–J, Chen C–C., *Food Chem.*, **2004**, *87*, 111–118.
59. Elmastas M., Turkekul I., Ozturk L., Gulcin I., Isildak O., Aboul-Enein H. Y., *Combinatorial Chemistry & High Throughput Screening*, **2006**, *9*, 443–448.
60. Tomita I., Patent No. *JP 06046798 A*, **19940222.**
61. Iwahara M., Okayama Y., Patent *JP 07258022 A*, **19951009**.
62. Joshi P., Dhawan V., *Current Science*, **2005**, *89*, 635–640.
63. Cai L., Wang S., Li T., Xia Y., *Huaxi Yaoxue Zazhi*, **2006**, *21*, 111–113.
64. Shi G., Lu R.,Yang Y., Pan H., Guan Y., Han C., *Xibei Zhiwu Xuebao*, **2004**, *24*, 296–300.
65. Lei J., Patent *CN 1709447 A*, **20051221**.
66. Jiumei P., Patent *CN 1814259 A*, **20060809**.
67. Jiumei P., Patent *CN 1814236 A*, **20060809**.
68. Sun H., Ding J., Lin Z., Che F., *Yunnan Zhiwu Yanjiu*, **1980**, *2*, 213–223.
69. Gewali M. B., Unpublished result.
70. Mahalwal V. S., Ali M., *J Essent Oil-Bearing Plants*, **2002**, *5*, 83–89.
71. Bagchi A., Oshima Y., Hikino H., *Planta Med.*, **1991**, *57*, 282–283.
72. Chatterjee A., Basak B., Datta U., Banerji J., Neuman A., Prange T., *Ind J Chem.*, **2005**, *44*, 430–433.
73. Chatterjee A., Basak B., Saha M., Dutta U., Mukhopadhyay C., Banerji J., Kondo Y., Harigaya Y., *J Nat Prod.*, **2000**, *63*, 1531−1533.
74. Bagchi A., Oshima Y., Hikino H., *Tetrahedron*, **1990**, *46*, 1523–1530.
75. Maheshwari M. L., Saxena D. B., *Ind J Chem.*, **1974**, *12*, 1221–1222.
76. Ruecker G., Tautges J., Maheswari M. L., Saxena D. B., *Phytochemistry*, **1976**, *15*, 224.
77. Bagchi A., Oshima Y., Hikino H., *Planta Med.*, **1991**, *5*, 96–97.
78. Mishra D., Chaturvedi R.V., Tripathi S.C., *Trop Agric.*, **1995**, *258*, 48–52.
79. Rao J. T., *PAFAI Journal*, **1986**, *8*, 27–28.
80. Saxena D. B., Goswami B. K., Tomar S. S., *Ind Perfumer.*, **1987**, *31*, 150–154.
81. Ali S., Ansari K. A., Jafry M. A., Kabeer H., Diwakar G., *J Ethnopharmacol.*, **2000**, *71*, 359–363.
82. Salim S., Ahmad M., Zafar K. S., Ahmad A. S., Islam F., *Pharmacol Biochem Behav.*, **2003**, *74*, 481–486.
83. Dixit V. P., Jain P., Joshi S. C., *Ind J Physiol Pharmacol.*, **1988**, *32*, 299–304.
84. Joshi H., Parle M., *J Med Food.*, **2006**, *9*, 113–118.
85. Subashini R., Yogeeta S., Gnanapragasam A., Devaki T., *J Pharm Pharmacol.*, **2006**, *58*, 257–262.
86. Athima S., Arunporn I., Chawaboon D., Chatchai W., Niwat K., Pranee R., *Songklanakarin J Sci Technol.*, **2005**, *27*, 469-478.
87. Arora R. B., Madan B. R., *Ind J Med Res.*, **1956**, *44*, 259–269.
88. Ruecker G., Tautges J., Sieck A., Wenzl H., Graf E., *Arzneimittel–Forschung*, **1978**, *28*, 7–13.
89. Ahmad M., Yousuf S., Khan M., Badruzzaman, Hoda M., Ahmad A. S., Ansari M. A., Ishrat T., Agrawal A. K., Islam F., *Biochem Behav.*, **2006**, 83, 150–160.
90. Dhingra D., Goyal P. K., *Ind J Expt Biol.*, **2008**, *46*, 212–218.
91. Arora R. B., Sharma P. L., Kapla K., *Ind J Med Res.*, **1985**, *46*, 782–791.
92. Arora R. B., Singh M., Arora C. K., *Life Sci.*, **1962**, *6*, 225.
93. Parajuli R. R., Tiwari R. D., Chaudhary R. P., Gupta V. N., *Scientific World*, **2005**, *3*, 39–43.

94. Mahmud S., Malik S., Sattar A., *Sci International*, **1994**, *6*, 167–168.
95. De Pooter H. L., Schamp N. M., Aboutabl E. A., El Tohamy, S. F., Doss, S. L., *Flavour & Fragrance*, **1991**, *6*, 229–232.
96. Naseri N. G., Ashnagar A., Husseini S., *Asian J Chem.*, **2006**, *18*, 1545–1547.
97. Waheed A., Sattar A., Ahmad K. S., *Pro Pak Acad of Sci.*, **1994**, *31*, 15–20.
98. Kawashty S. A., Mosharrafa S. A. M.,El-Gibali M., Saleh N. A. M., *Biochem Systematics Ecol.*, **2000**, *28*, 915–917.
99. Wang D., He Z., Feng B., Yang C., *Yunnan Zhiwu Yanjiu*, **1993**, *15*, 83–88.
100. Li J. X., Li P., Tezuka Y., Namba T., Kadota S., *Phytochemistry*, **1998**, *48*, 537–542.
101. Wang H., Ye W. C., Jiang R. W., Wu J. J., Mak Thomas C. W., Zhao S. X., Yao X. S., *Planta Med.*, **2004**, *70*, 382–384.
102. Wang H., Wu F., Xiong F.,Wu J., Zhang L., Ye W., Li P., Zhao S., *Chem Pharm Bull.*, **2006**, *54*, 1144–1154.
103. Huang S. X.,Zhou Y., Nie Q.J., Ding L.S., Peng S.L., *J Asian Nat Prod Res.*, **2006**, *8*, 259–263.
104. Wang H., Sun Y., Ye W. C., Xiong F., Wu J. J., Yang C. H., Zhao S. X., *Chem Pharm Bull.*, **2004**, *52*, 615–617.
105. Huang S. X., Liao X., Nie Q. J., Ding L. S., Peng S. L., *Helve Chim Acta.*, **2004**, *87*, 598–604.
106. Zou X., Liao X., Ding L. S., Peng S. L., *J Asian Nat Prod Res.*, **2007**, *9*, 443–448.
107. Wang H., Ye W. C., Zhao S. X., *Biochem Systematics Ecol.*, **2004**, 32, 87–89.
108. Zhu T. F., Huang K. Y., Deng X. M., Zhang Y., Xiang H., Gao H. Y., Wang D. C., *Molecules*, **2008**, *13*, 729–735.
109. Smit H. F., Kroesa B. H., van den Berga A. J. J., van der Wala D., van den Worma E., Beukelmana C. J., van Dijkb H., Labadiea R.P., *J Ethnopharmacol.*, **2000**, *73*, 101–109.
110. Sun M., Fan H. W., Ma H.Y., Zhu Q., *Yao Xue Xue Bao*, **2007**, *42*, 381−385.
111. Li P., Matsunaga K., Ohizumi Y., *Biol Pharm Bull.*, **1999**, *22*, 752–755.
112. Li P., Matsunaga K., Ohizumi Y., *Biol Pharm Bull.*, **2000**, *23*, 890–892.
113. Gao H., Zhou Y., *Acta Pharmacologica Sinica*, **2005**, *26*, 729–736.
114. Kima D.,Wooc E., Chaea, S., Haa K., Leea G., Hongd S., Kwone D., Kime M., Jungf Y., Kimg H., Kima H., Kimb H., *Life Sci.*, **2007**, *80*, 314–323.
115. Smit H. F., Van den Berg A. J. J., Kroes B. H., Beukelman C. J., Quarles van Ufford H. C., Van Dijk H., Labadie R. P., *J Nat Prod.*, **2000**, *63*, 1300–1302.
116. Sasaki T., *Yakugaku Zasshi*, **1965**, *85*, 547–552.
117. Talapatra S. K., Karmacharya B., De S. C., Talapatra B., *Phytochemistry*, **1988**, *27*, 3929–3932.
118. Fukuda T., Ito H., Yoshida Y., *Phytochemistry*, **2003**, *63*, 795–801.
119. Jin Z. X., Qu Z. Y., *Zhongguo Zhong Yao Za Zhi*, **2007**, *32*, 1541.
120. Li L., Tsao R., Yang R., Kramer J. K.G., Hernandez M., *J Agric Food Chem.*, **2007**, 55, 1164–1169.
121. Liu J. X., Di D. L., Huang X. Y., Li C., *Chin Chem Lett.*, **2007**, *18*, 943–946.
122. Yaylaci F., Kolayli S., Kucuk M., Karaoglu S. A.,Ulusoy E., *Asian J Chem.*, **2007**, *19*, 2241–2256.
123. Wei Q.,Ma X., Han X., He T., *Shipin Kexue*, **2001**, *22*, 81–83.
124. Kantemir I., *Acta Medica Turcica*, **1966**, 3, 1–15.
125. Shimoda H., Kikuchi M, *Food Style*, **2007**, *11*, 52−53.
126. Babula P., Adam V., Havel L., Kizek R., *Ceska a Slovenska Farmacie*, **2007**, *56*, 114–120.
127. Agarwal S. K., Singh S. S., Verma S., Kumar S., *J Ethnopharmacol.*, **2000**, *72*, 43–46.
128. Singh S. S., Pandey S. C., Singh R., Agarwal S. K., *Ind J Chem.*, **2005**, *44B*, 1494–1496.
129. Suresh B. K., Srinivas P. V., Praveen B., Hara K. K., Suryanarayana M. U., Madhusudana R. J., *Phytochemistry*, **2003**, *62*, 203–207.
130. Krenn L., Presser A., Pradhan R., Bahr B., Paper D. H., Mayer K. K., Kopp B., *J Nat Prod.*, **2003**, *66*, 1107–1109.
131. Agarwal S. K., Singh S. S., Verma S., Kumar S., *Ind J Chem.*, **1999**, *38B*, 749–751.
132. Krenn L.,Pradhan R., Presser A., Reznicek G., Kopp B., *Chem Pharm Bull.*, **2004**, *52*, 391–393.
133. Liu B., Yang J., Wang S., *Huaxi Yaoxue Zazhi*, **2007**, *22*, 33–35.
134. Ibrahim M., Khan A. A., Tiwari S. K., Habeeb M. A., Khaja M. N., Habibullah C. M., *World J. Gastroenterol.*, **2006**, *12*, 7136–7142.
135. Kabrodt K., Schellenberg I., Patent *DE 102006015573 A1*, **20071004**.
136. Kabrodt K., Schellenberg I., Lendeckel U., Wolke C., Patent *DE 102006015574 A1*, **20071004**.
137. Kabrodt K., Schellenberg I., Patent *DE 102006015575 A1*, **20071004**.

138. Hameed H. A., Patent *IN 183199 A1*, **19991002**.
139. Luosang D., Patent *CN 1799425 A*, **20060712**.
140. Luosang D., Patent *CN 1799427 A*, **20060712**.
141. Hazarika A. K., Bhagat S. D., *Ind Perfumer.*, **1984**, *28*, 98–104.
142. Coppen J. J. W., Robinson J. M., Kaushal A. N., *Phytochemistry*, **1988**, *27*, 2873–2875.
143. Malik M.N., Khan A. A., *Pak J Forestry.*, **1967**, *17*, 371–376.
144. Matsunaga Y., Shibata M., Iriyama S., Amano S., Kusakari K., Ota M., Umishio K., Patent *WO 2008044636 A1*, **20080417**.
145. Singh A., Srivastava S. N., Kapoor L. D., *Ind J Chem.*, **1966**, *4*, 460–461.
146. Singh S. B., Thakur R. S., *Tetrahedron*, **1982**, *38*, 2189–2194.
147. Seshadri T. R., Vydeeswaran S., *Ind J Chem.*, **1972**, *10*, 589–591.
148. Nohara T., Yabuta H., Suenobu M., Hida R., Miyahara K., Kawasaki T*., Chem Pharm Bull.,* **1973**, *21*, 1240–1247.
149. Khanna I., Seshadri R., Seshadri T. R., *Ind J Chem.*, **1975**, *13*, 781–784.
150. Singh S. B., Thakur R. S., *Planta Med.*, **1980**, *40*, 301–303.
151. Liu H., Zhang T., Chen X., Huang Y., Wang Q., *Zhongguo Tianran Yaowu*, **2006**, *4*, 264–267.
152. Pan Y., Ying L., Wang H., Min L., *Food Chem.*, **2004**, *88*, 347–350.
153. Wang Q., Xu G., Jiang Y., *J Chin Mater Med.*, **1990**, *15*, 109–111.
154. Lee H., Lin J.Y., *Mutat Res.*, **1988**, *204*, 229–234.
155. Cao L.S., Shuren, Liu C., *Zhongcaoyao*, **1987**, *18*, 451–453.
156. Matsuda H., Pongpiriyadacha Y., Morikawa T., Kishi A., Kataoka S., Yoshikawa M., *Bioorg Med Chem Lett.*, **2003**, *13*, 1101–1106.
157. Wang Y., Zhang Y., Gao W., Yan L., *J Chin Mater Med.*, **2007**, *32*, 1425–1428.
158. Yuen–Nei Cheung J., Chik–Ying Ong R., Suen Y.,Ooi V., Nai–Ching H., Chung–Wai Mak T., Fung K.,Yu B., Kong S., *Cancer Lett.*, **2005**, *217*, 203–211.
159. Lee M.S., Yuet-Wa J.C., Kong S.K., Yu B., Eng-Choon V.O., Nai-Ching H.W., Chung-Wai T.M., Fung K.P., *Cancer Biol Ther.*, **2005**, *4*, 1248–1254.
160. Devkota K. P., Khan M. T., Ranjit R., Lannang A. M., Samreen, Choudhary M. I., *Nat Prod Res.*, **2007**, *21*, 321–327.
161. Zhang X. F., Cui Y., Huang J. J., Zhang Y. Z., Nie Z., Wang L. F., Yan B. Z., Tang Y. L., Liu Y., *Bioorg Med Chem Lett.*, **2007**, *17*, 2408–2413.
162. Ravikumar P. R., Soman R., Chetty G. L., Pandey, R. C., Sukh D., *Ind J Chem.*, **1987**, *26B*, 1012–1017.
163. Joshi J., Sukh D., *Ind J Chem.*, **1988**, *27B*, 12–16.
164. Hayes P. Y., Jahidin A. H., Lehmann R., Penman K., Kitching W., De Voss J. J., *Tetrahedron Lett.*, **2006**, *47*, 8683-8687.
165. Hayes P. Y., Jahidin A. H., Lehmann R., Penman K., Kitching W., De Voss J. J., *Phytochemistry*, **2008**, *69*, 796–804.
166. Handa S. S., Suri O. P., Gupta V. N., Suri K. A., Satti N. K., Bhardwaj V., Bedi K. L., Khajuria A.,Kaul A.,Parikh K., Kulhe P., Salunkhe U., Krishnamurth R., Patent WO *2003080067 A1*, **20031002**.
167. Mandal D., Banerjee S., Mondal N. B., Chakravarty A. K., Sahu N. P., *Phytochemistry*, **2006**, *67*, 1316–1321.
168. Hayes P. Y., Jahidin A. H., Lehmann R., Penman K., Kitching W., De Voss J.J., *Tetrahedron Lett.*, **2006**, *47*, 6965–6969.
169. Sekine T., Fukasawa N., Kashiwagi Y., Ruangrungsi N., Murakoshi I, *Chem Pharm Bull.*, **1994**, *42*, 1360–1362.
170. Subramanian S. S., Nair A. G. R., *Current Science*, **1968**, *37*, 287– 288.
171. Sekine T., Fukasawa N., Kashiwagi Y., Murakoshi I, Ruangrungsi N., *Phytochemistry*, **1997**, 44, 763–764.
172. Saxena V. K., Chourasia S., *Fitoterapia*, **2001**, *72*, 307–309.
173. Saxena V. K., Choubasia S., *J Institu Chemist* (India), **2000**, *72*, 211–213.
174. Wiboonpun N., Phuwapraisirisan P., Tip-pyang S., *Phytother Res.*, **2004**, *18*, 771–773.
175. Landge A. B., Bose J. L., *Ind J Chem.*, **1970**, *8*, 588–589.
176. Subramanian S. S.,Nair A. G. R., *Current Science* ,**1969**, *38*, 414.
177. Mandal S. C, Nandy A., Pal M., Saha B. P., *Phytother Res.*, **2000**, *14*, 118–119.

178. Kamat J. P., Boloor K. K., Devasagayam T. P.,Venkatachalam S. R., *J Ethnopharmacol.*, **2000**, *7*, 425–435.
179. Swarup G., Sharma R.D., *Ind J Exp Biol.*, **1967**, *5*, 59.
180. Venkatesan N., Thiyagarajan V., Narayanan S., Arul A., Kumar R. S. V , Sengodan Gurusamy; Thandavarayan R., Perianayagam J. B., *J Pharm Pharm Sci.*, **2005**, *8*, 39–46.
181. Christina A. J. M., Ashok K., Packialakshmi M., Tobin G. C., Preethi J., Murugesh N., *Methods Find Exp Clin Pharmacol.*, **2005**, *27*, 633–638.
182. Bhatnagar, M., Sisodia S. S., Bhatnagar R., *Ann N Y Acad Sci.*, **2005**, *1056*, 261–278.
183. Dhingra D., Kumar V., *Pharmacologyonline*, **2007**, *3*, 133–152.
184. Gaitonde B. B., Jetmalani M. H., *Arch Int Pharmacodyn Ther.*, **1969**, *179*, 121–129.
185. Phuwapraisirisan, P., Poapolathep, A., Poapolathep, S., Tip-pyang, S., *ACGC Chem Res Commun.*, **2006**, 20, 17–19.
186.Jetmalani M. H., Sabnis P. B., Gaitonde B. B., *J Res Ind Med.*, **1969**, *21*, 1–9.
187. Pandey S. K., Sahay A., Pandey R. S., Tripathi Y. B., *Phytother Res.*, **2005**, *19*, 721–724.
188. Agrawal A., Sharma M., Rai S. K., Singh B., Tiwari M., Chandra R., *Phytother Res.*, **2008**, 22, 1175–1182.
189. Tip-Pyang S.,Tangpraprutgul P., Wiboonpun N., Veerachato G., Phuwapraisirisan P., Sup-Udompol B., *ACGC Cheml Res Commun.*, **2000**, *12*, 31–35.
190. Thatte U. M., Dahanukar S. K., *Methods Find Exp Clin Pharmacol.*, **1988**, *10*, 639–644.
191. Gautam M., Diwanay S., Gairola S., Shinde Y., Patki P., Patwardhan B., *J Ethnopharmacol.*, **2004**, *91*, 251–255.
192. Hannan J. M. A., Marenah L., Ali L., Rokeya, B., Flat P. R., Abdel-Wahab Y. H., *J Endocrinol.*, **2007**,*192*, 159–168.
193. Govindarajan R., Vijayakumar, M., Rao C. V., Kumar V., Rawat A. K.S., Pushpangadan P., *Nat Prod Sci.*, **2004**, *10*, 177–181.
194. Mandal S. C., Maiti B. C., Maity T. K., Pal M., Saha B. P., *Natural Product Sciences*, **1998**, *4*, 230–233.
195. Gupta P. P., Srimal R. C., Tandon J. S., *Int J Pharmacog.*, **1993**, *31*, 15–18.
196. Dalvi S. S., Nadkarni P. M., Gupta K. C., *J Postgrad Med.*, **1990**, *36*, 91–94.
197. Bopana N., Saxena S., *J Ethnopharmacol.*, **2007**, *110*, 1–15.
198. Velavan S., Nagulendran K. R., Mahesh R., Begum V. H., *Pharmacog Rev.*, **2007**, *1*, 350–360.
199. Yang Z., Peng Q., Yang M., Wang D., *Zhongguo Yaoxue Zazhi*, **2006**, 41, 74–75.
200. Sati S., Chanotiya C. S., Mathela C. S., *J Essent Oil Res.*, 2005, *17*, 408−409.
201. Hoelzl J., Jurcic K., *Planta Med.*, **1975**, *27*, 133–139.
202. Tang Z., Liu X., Yu B., *J Nat Prod.*, **2002**, *65*, 1949–1952.
203. Ming D. S., Yu D. Q., Yang Y. Y., He C. H., *Tetrahedron Lett.*, **1997**, *38*, 5205–5208.
204. Tang Y.P., Liu X., Yu B., *J Asian Nat Prod Res.*, **2003**, *5*, 257–261.
205. Thind T. S., Suri R. K., *Ind Perfumer.*, **1979**, *23*, 138–140.
206. Girgune J. B., Jain N. K., Garg B. D., *Ind J Microbiol.*, **1980**, *20*, 142–143.
207. Cao B., Hong G. X., *China J Chin Mater Med.*, **1994**, *19*, 40–42.
208. Xinghua M., Patent *CN 1864730 A*, **20061122**.
209. Wang H., Patent *CN 1814232 A*, **20060809**.
210. Lan Z., Patent *CN 1814179 A*, **20060809**.
211. Yang Y., Patent *CN 1785407 A*, **20060614**.
212. Zhou P., Patent *CN 1683020 A*, **20051019**.
213. Zhou P., *Patent CN 1682687 A*, **20051019**.
214. Wasowski C., Marder M., Viola H., Medina J. H., Paladini A. C., *Planta Med.*, **2002**, *68*, 934−936.